

CSDNA using List-Mode Data: Progress and Problems

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Introduction

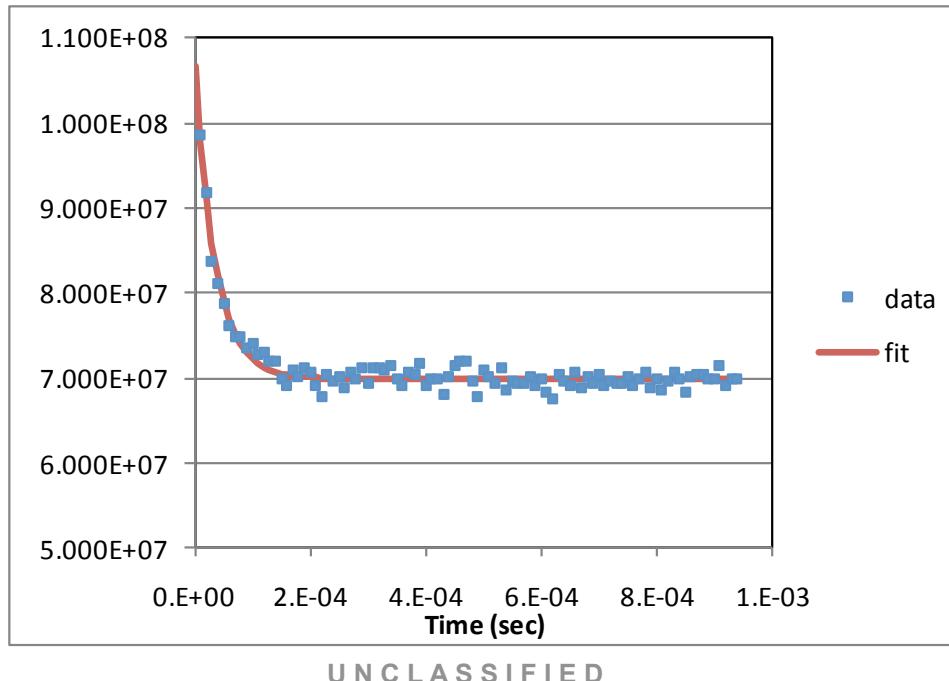
- Correlation analysis theory.
- Current measured data.
- MCNP-DSP example.
- Measured data with the 4 He-3 tube system.
- Measured data with the NPOD system.

Cf-252 Source-Driven Noise Analysis (CSDNA)

- Used by John Mihalczo and Tim Valentine of ORNL and John Mattingly (while at ORNL).
- Requires use of an external Cf-252 source in an ionization chamber (SIC).

Correlation analysis

$$\phi_{xy}(k\Delta) = \frac{1}{N - k} \sum_{i=1}^{N-k} x[t + i\Delta]y[t + (i + k)\Delta]$$



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Correlation analysis

- A FFT of the data are performed to transform the data from the time to the frequency domain.

$$\phi_{xx}(\tau) \rightarrow_{\text{FFT}} S_{xx}(\omega)$$

$$\phi_{xy}(\tau) \rightarrow_{\text{FFT}} S_{xy}(\omega)$$

- S is the auto (if “xx” or “yy”) or cross (if “xy”) spectra. Here x or y can refer to any detector channel (or combination of detector channels) or the source channel.

Correlation analysis

$$\gamma_{xy}^2(\omega) = \frac{|S_{xy}(\omega)|^2}{S_{xx}(\omega)S_{yy}(\omega)}$$

- Like with the auto and cross-spectra, for the coherence, x or y can refer to any detector channel (or combination of detector channels) or the source channel.

$$R_{xy}(\omega) = \sqrt{\frac{\gamma_{sx}^2(\omega)\gamma_{sy}^2(\omega)}{\gamma_{xy}^2(\omega)}}$$

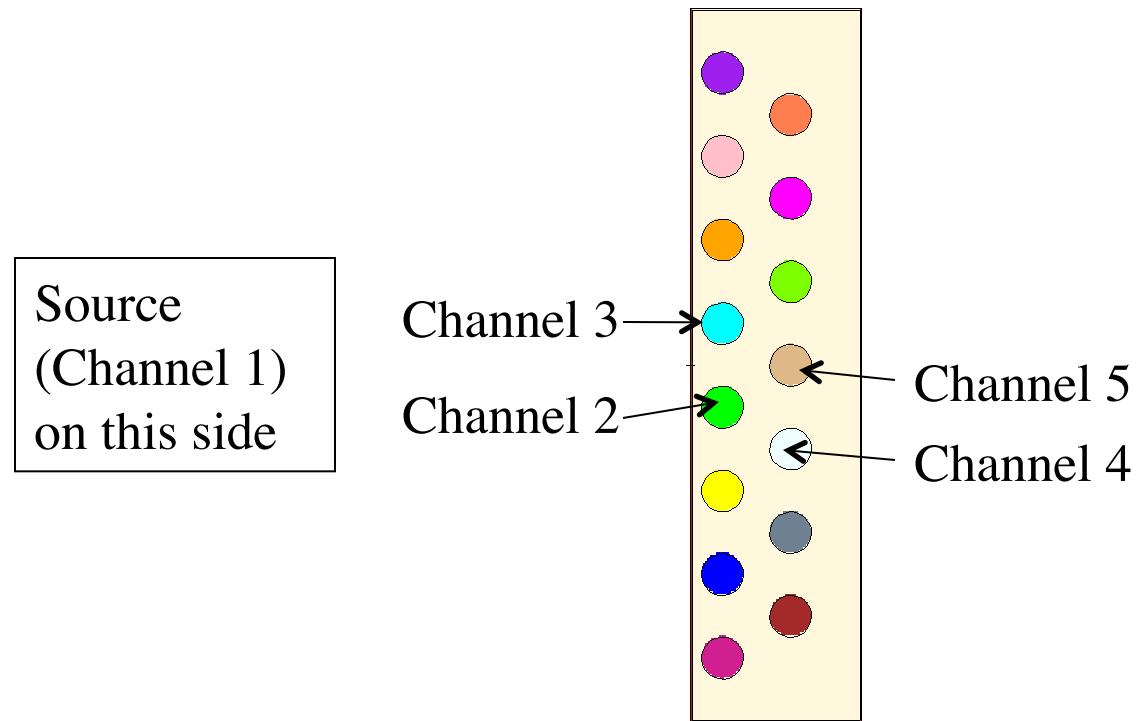
- Unlike the auto and cross-spectra and coherence, x or y can refer to any detector channel (or combination of detector channels) (but NOT the source channel, which is now referred to as S).

Available measured and simulated data with a Cf-252 SIC

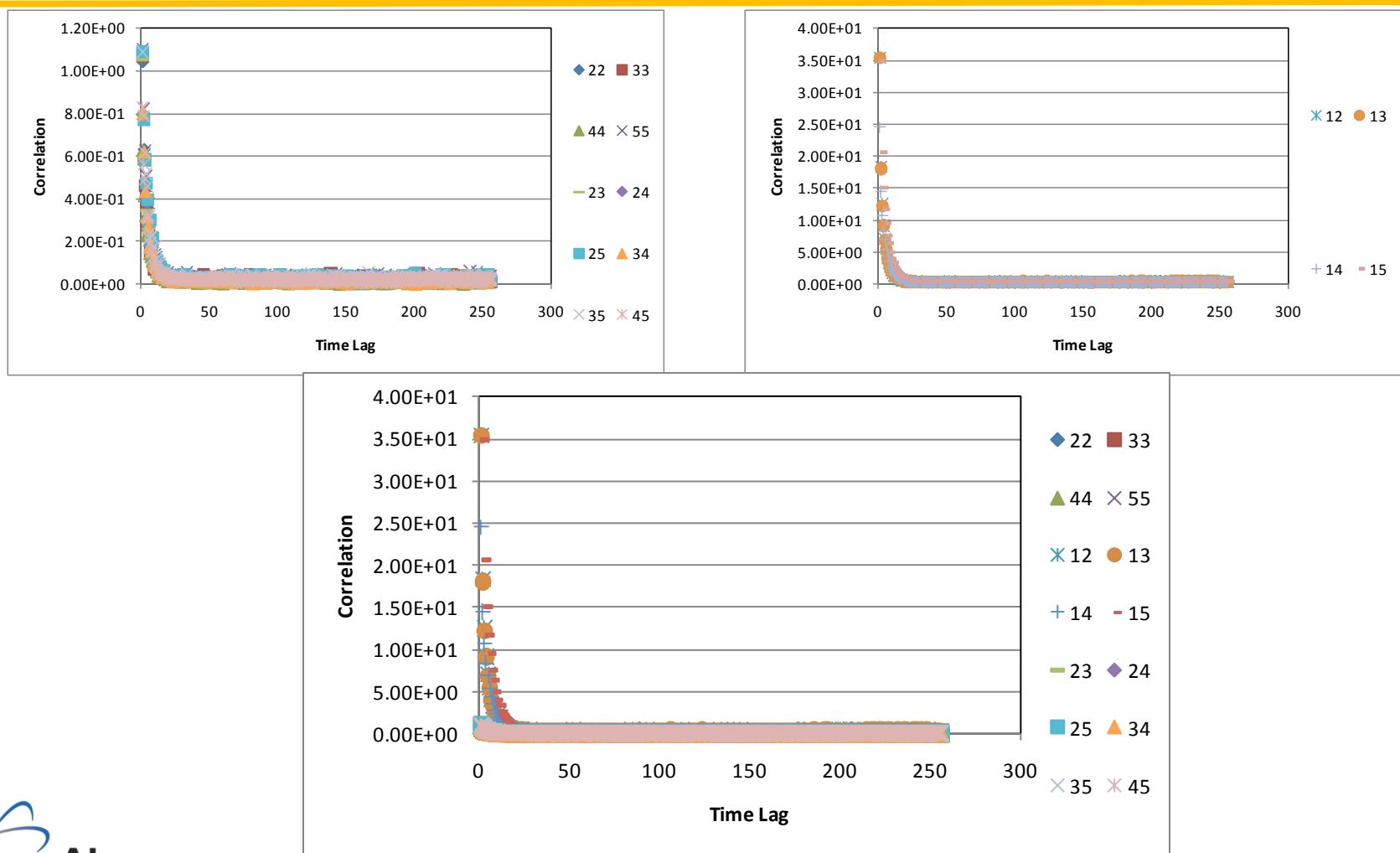
- 4 He-3 tube system (4 atm, 1" OD, 5" active height)
 - Measured, list-mode: Source CF-49 (or CF-52) with and without the BeRP ball (with polyethylene reflectors) using the PATRM acquisition system.
 - Measured, frequency domain: Source CF-49 (or CF-52) with and without the BeRP ball (with polyethylene reflectors) using the WCA acquisition system.
 - Simulated: Time and frequency domain simulations with MCNP-DSP.
- NPOD
 - Measured, list-mode: Source CF-49 (or CF-52) with and without the BeRP ball (with polyethylene reflectors) using the PATRM acquisition system.
 - Simulated: Limited time and frequency domain simulations with MCNP-DSP (4 channels only).

MCNP-DSP example

- NPOD detector system with Cf-252 source in void.

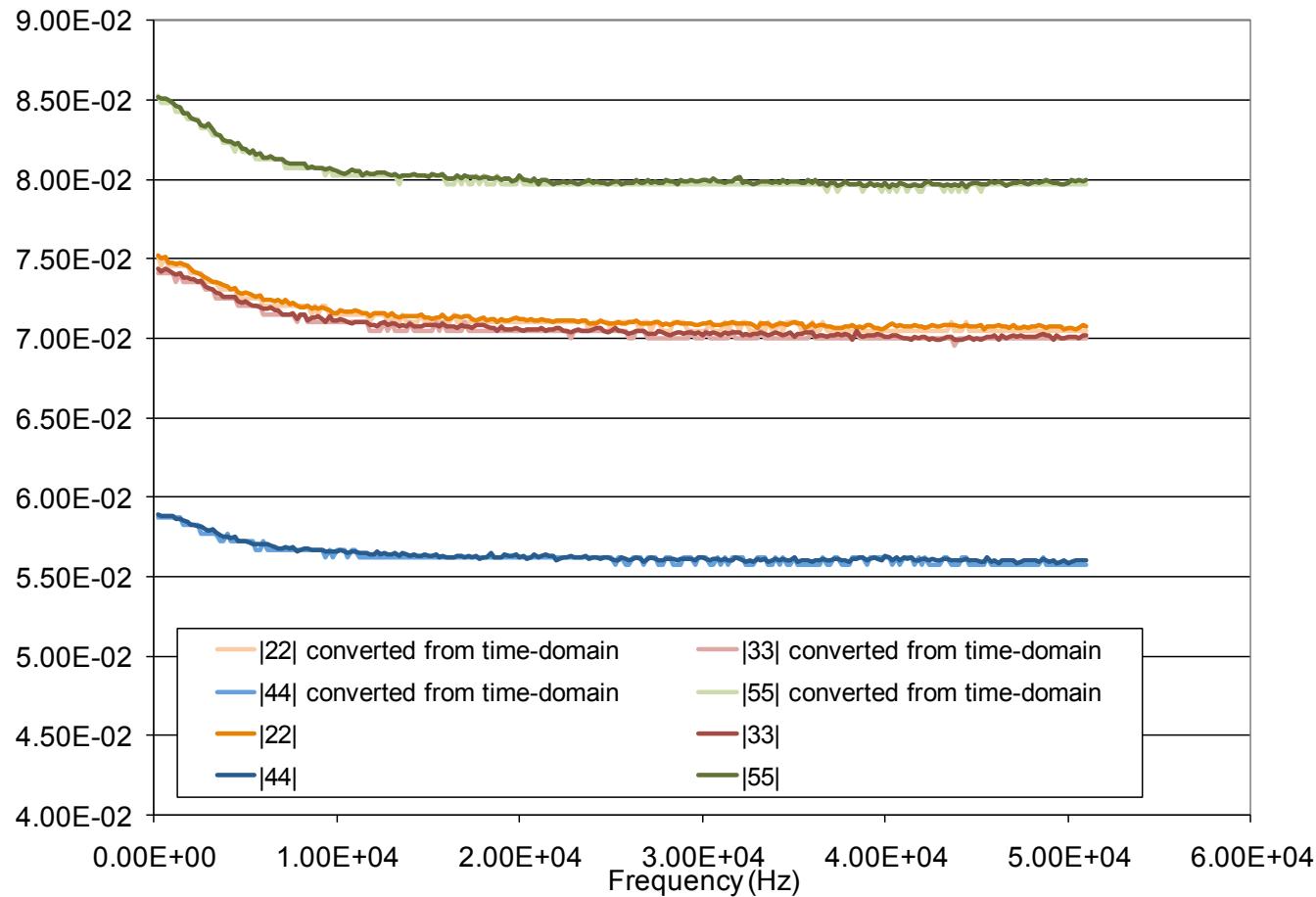


MCNP-DSP example: time-domain

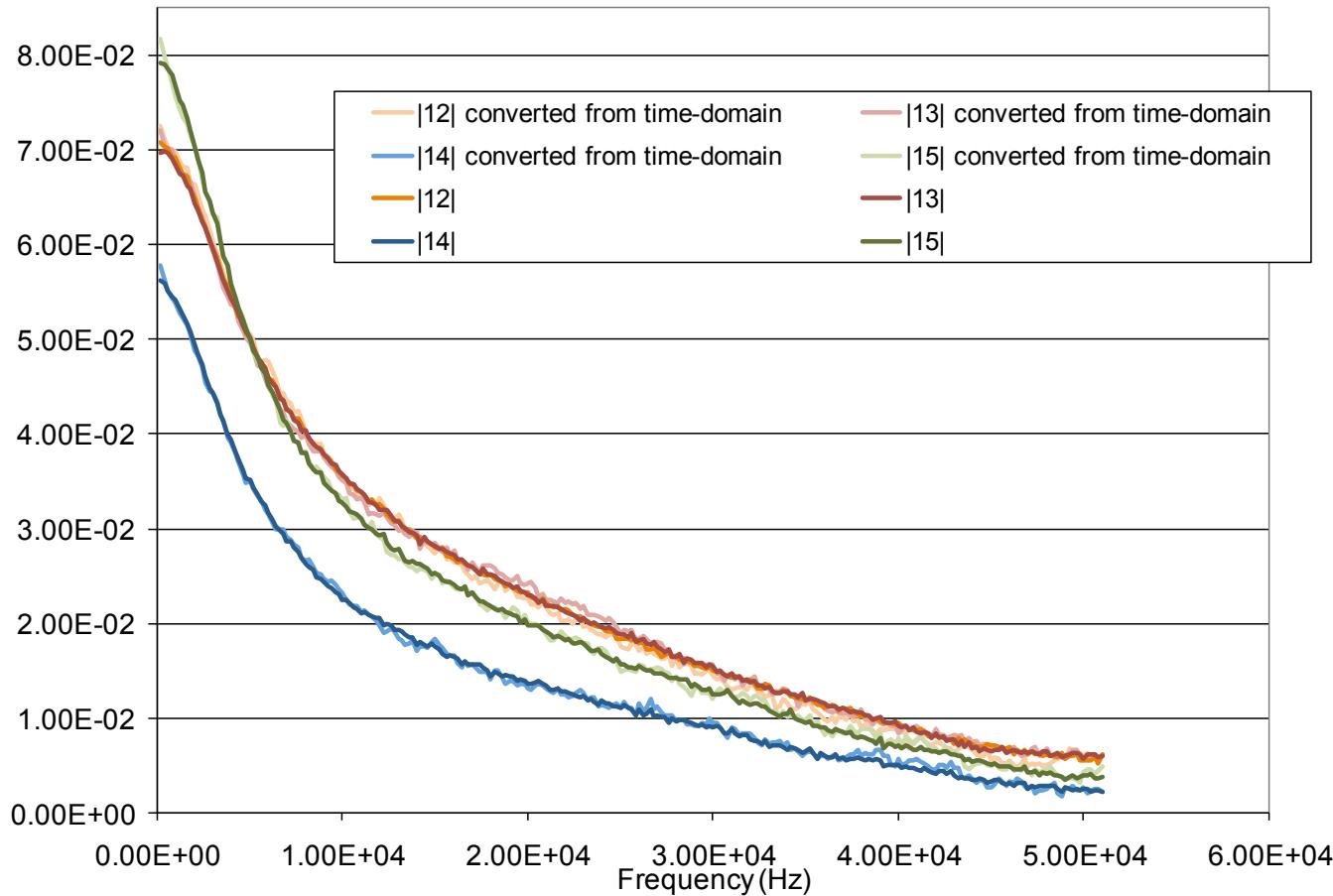


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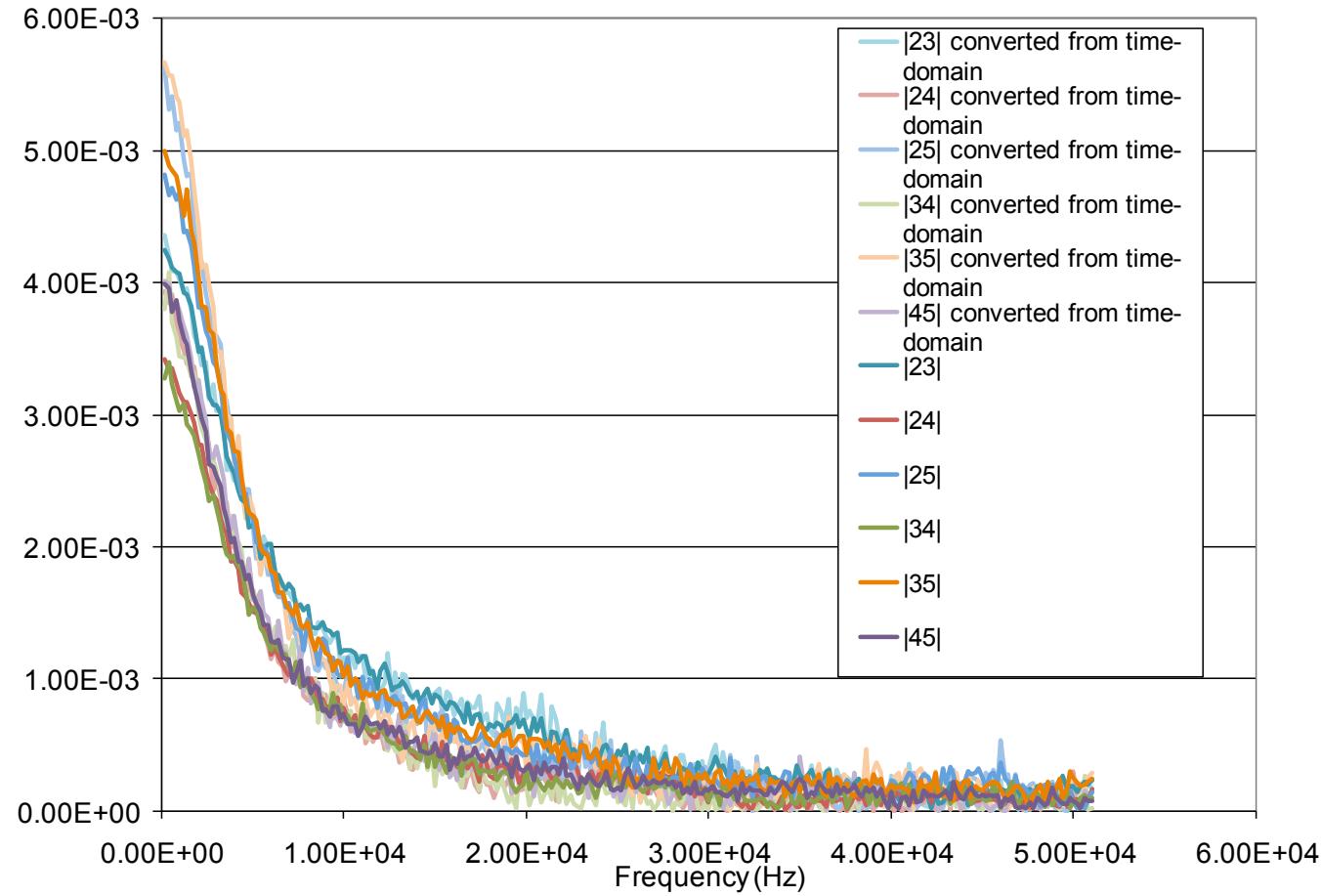
MCNP-DSP example: frequency-domain



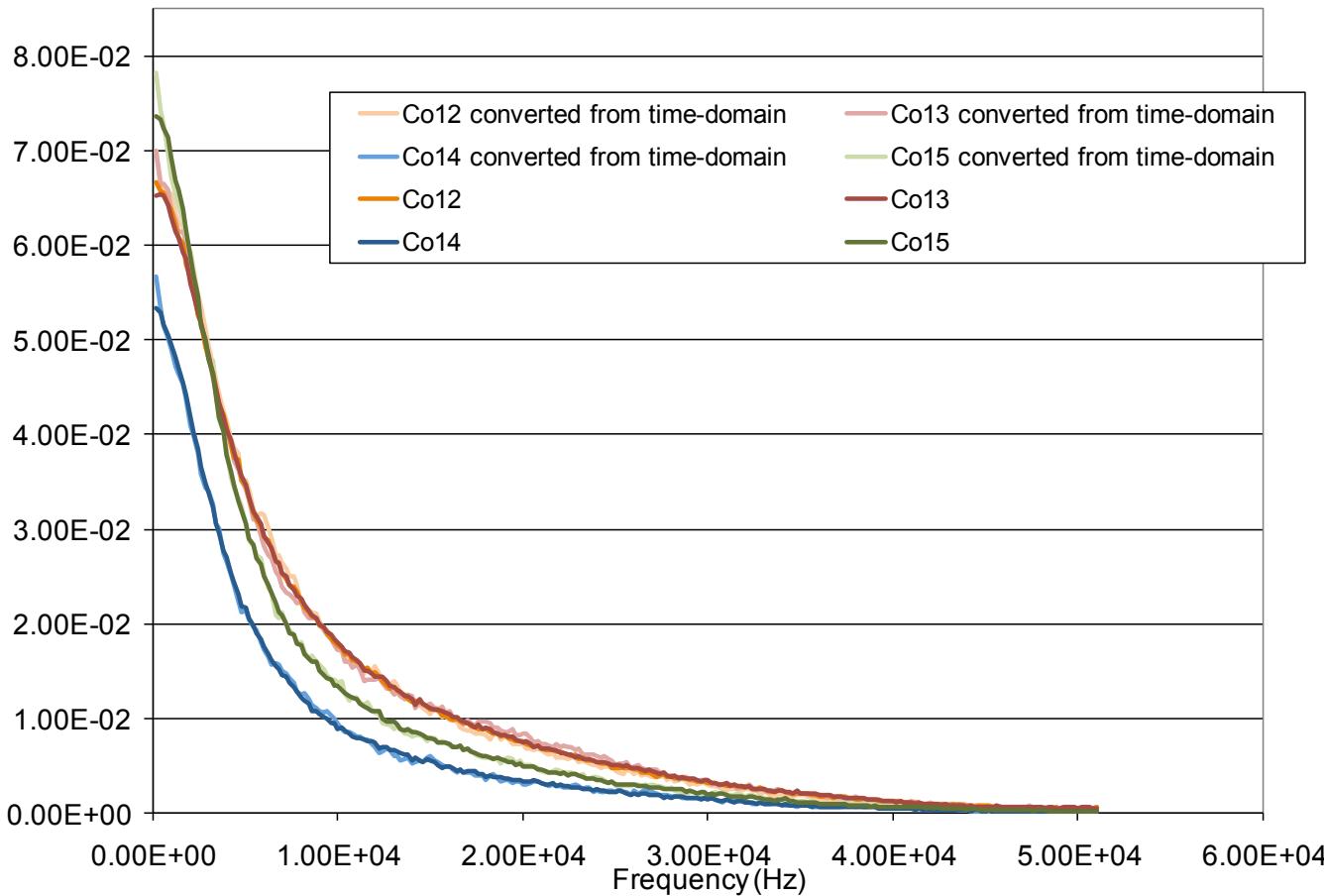
MCNP-DSP example: frequency-domain



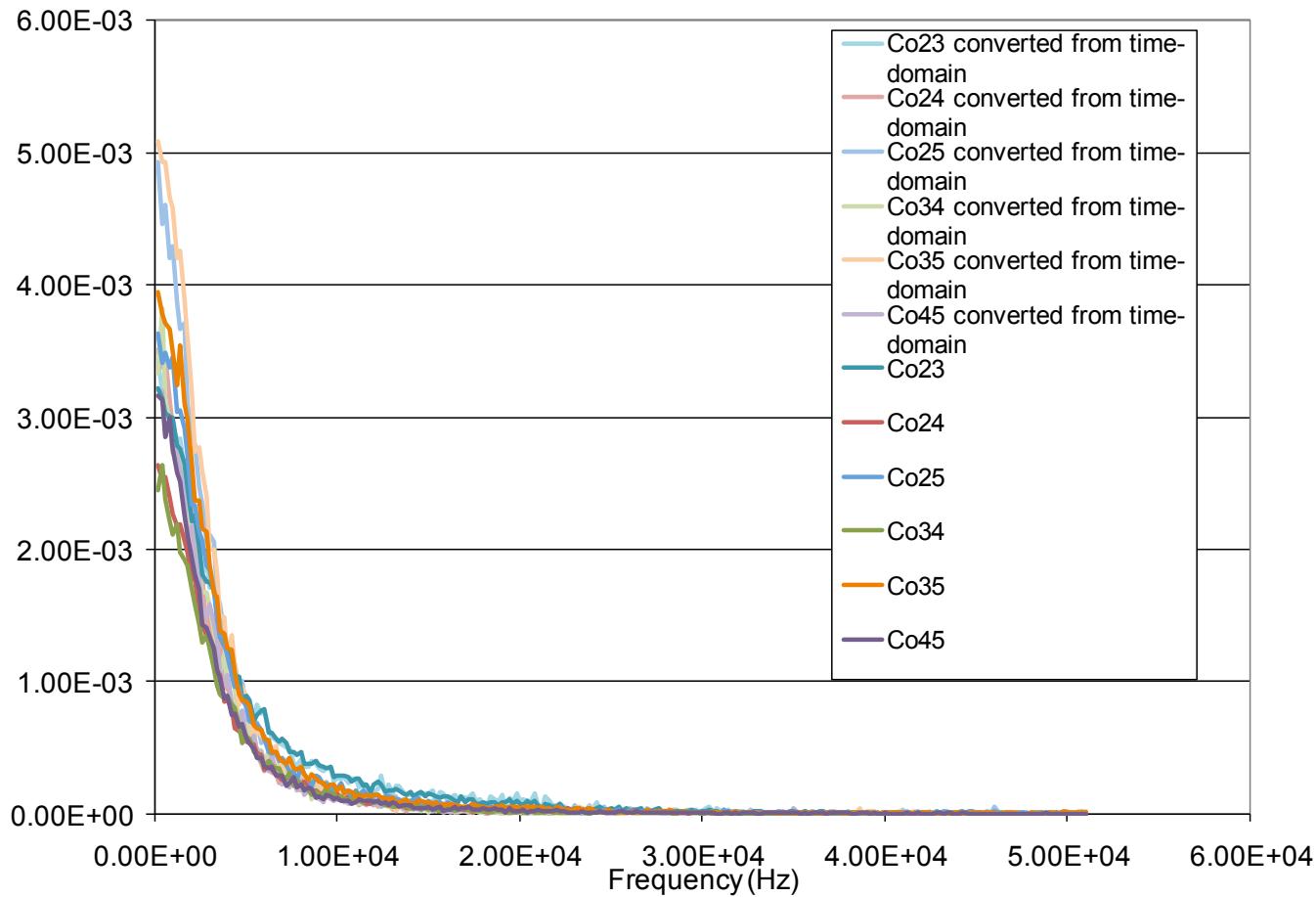
MCNP-DSP example: frequency-domain



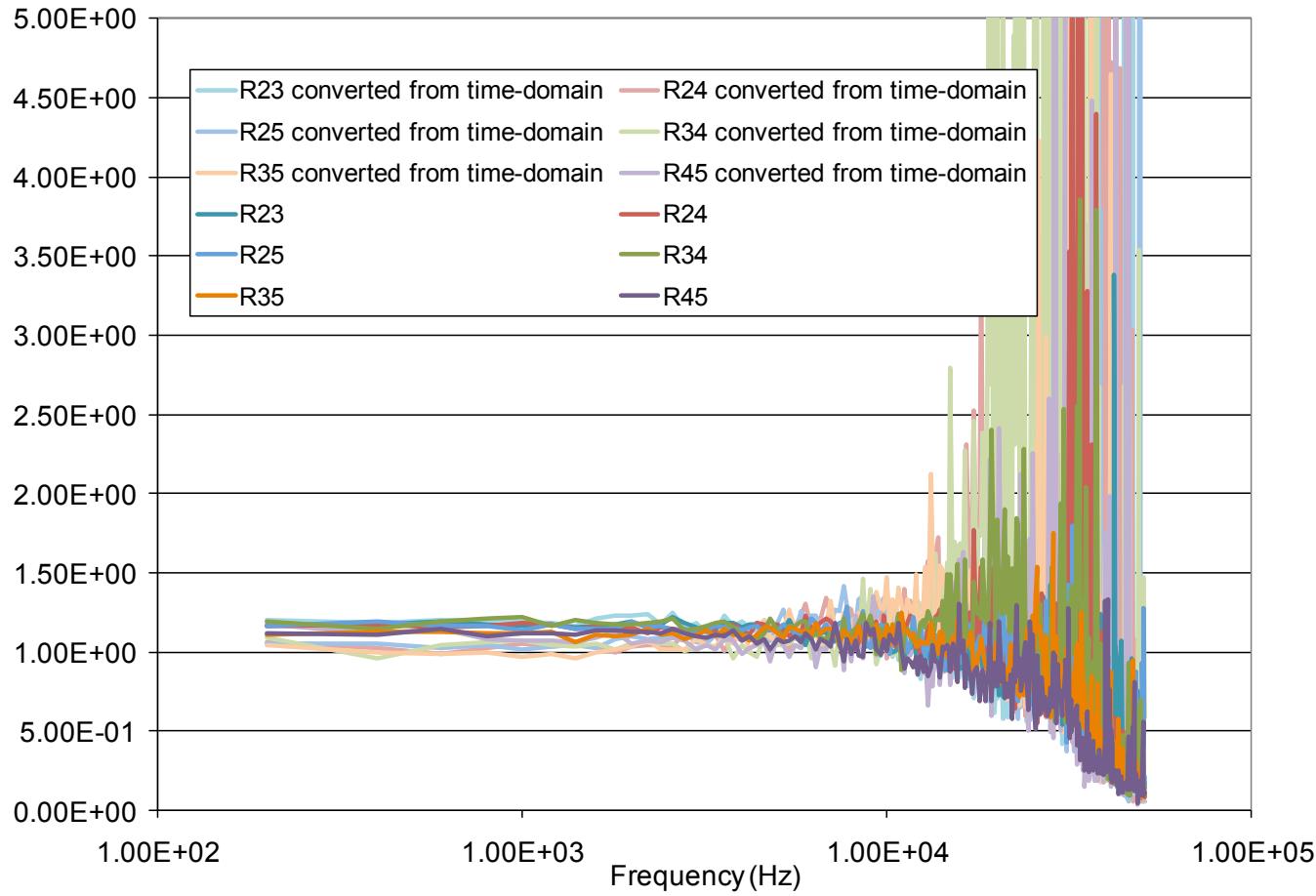
MCNP-DSP example: frequency-domain



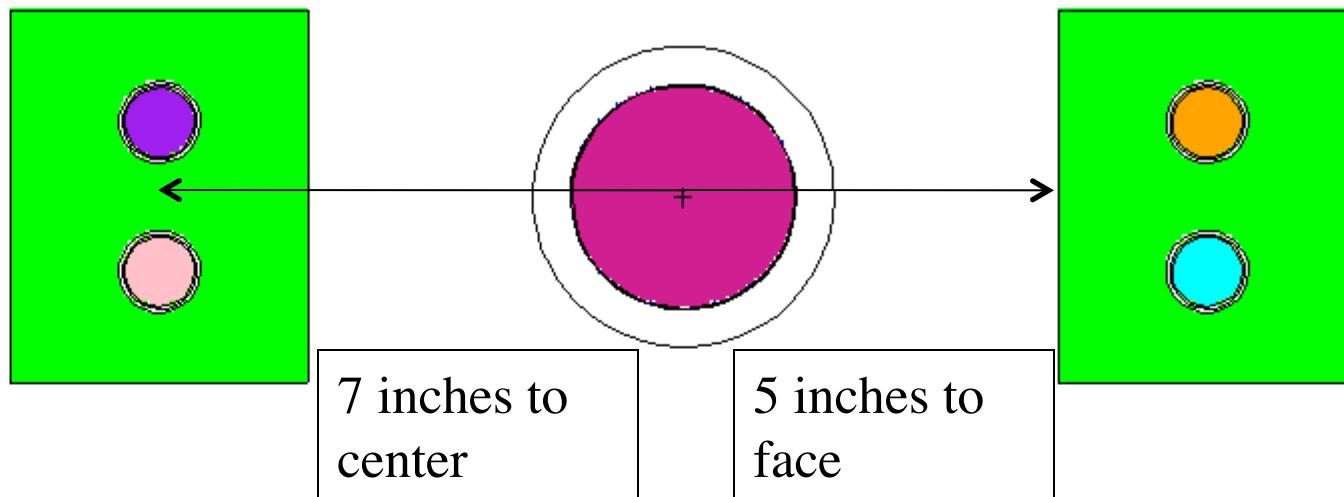
MCNP-DSP example: frequency-domain



MCNP-DSP example: frequency-domain

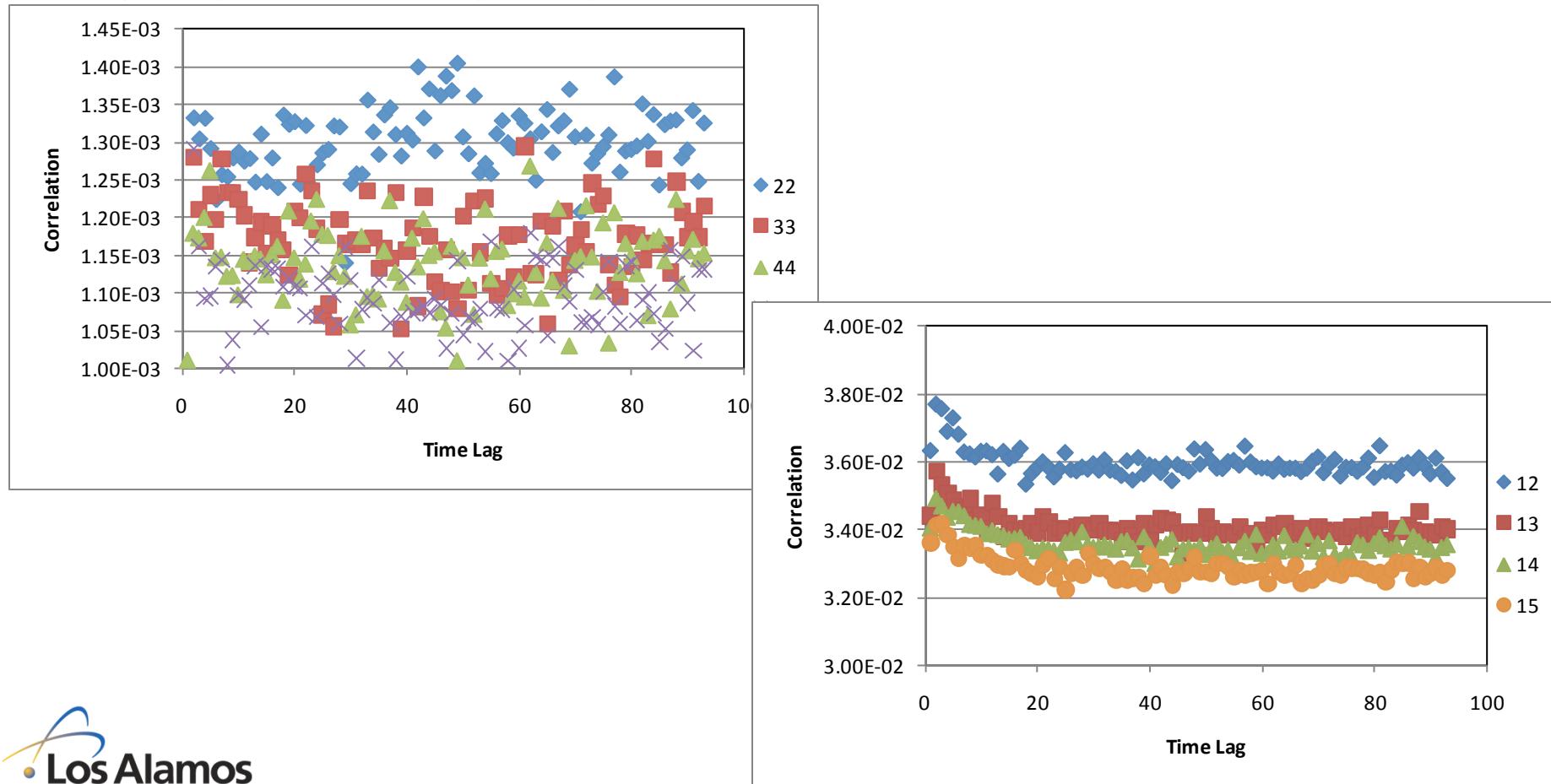


Measured data: 4 He-3 tube system



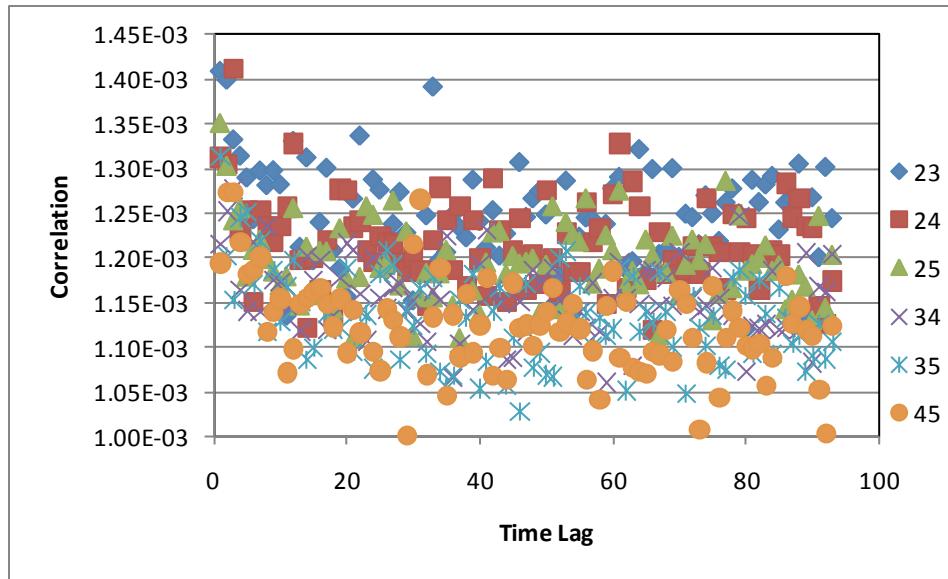
Measured data: 4 He-3 tube system

- Cf-252 source CF-49 and the bare BeRP ball.



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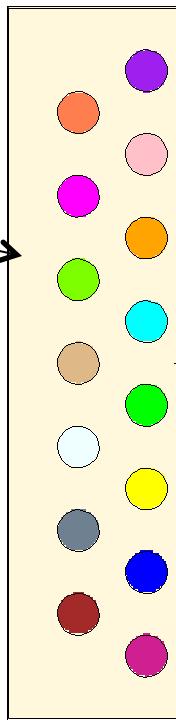
Measured data: 4 He-3 tube system



Measured data: NPOD

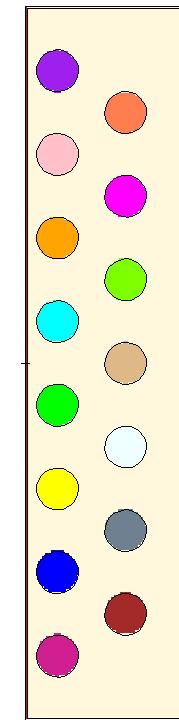
- Cf-252 source CF-49 and the bare BeRP ball.

Entire pod
treated as
Channel 2

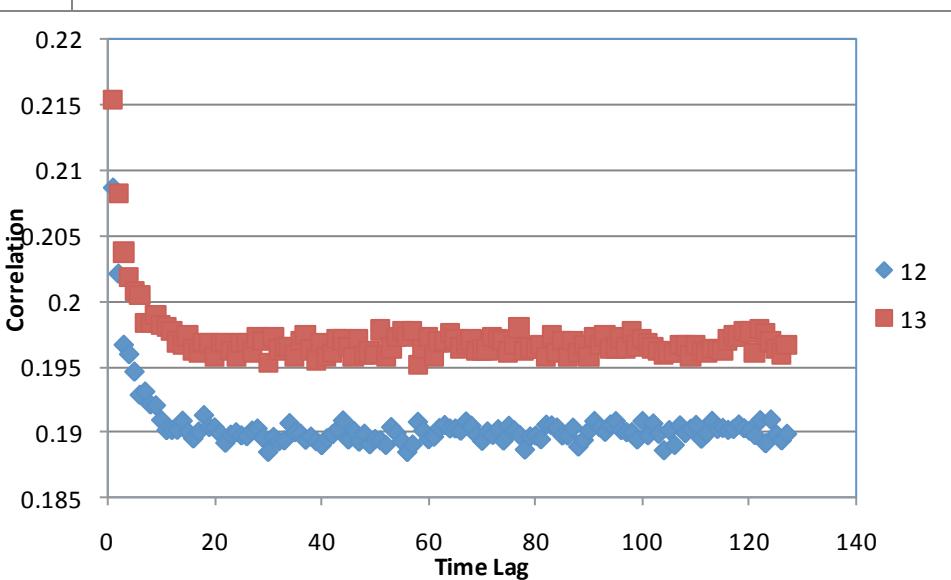
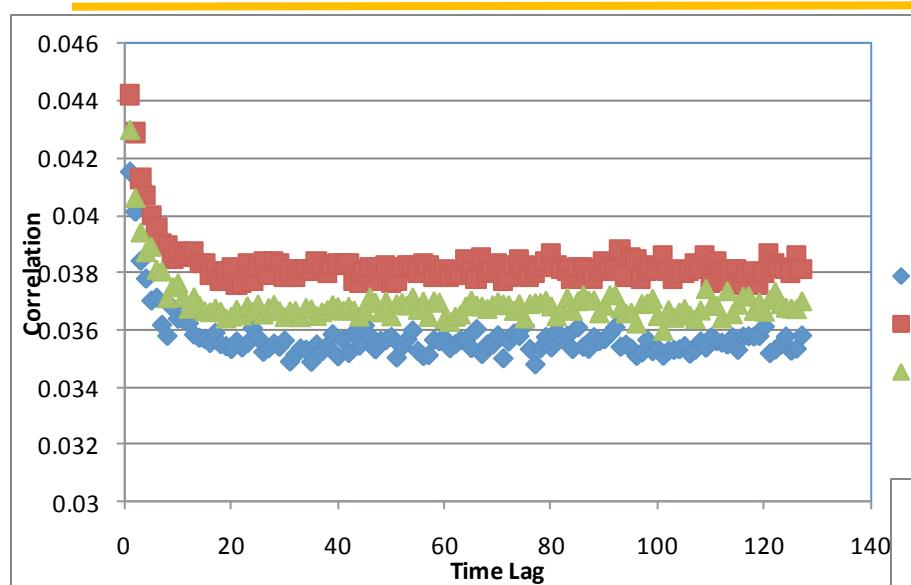


Source
(Channel 1)
& BeRP 50
cm from
each face

Entire pod
treated as
Channel 3

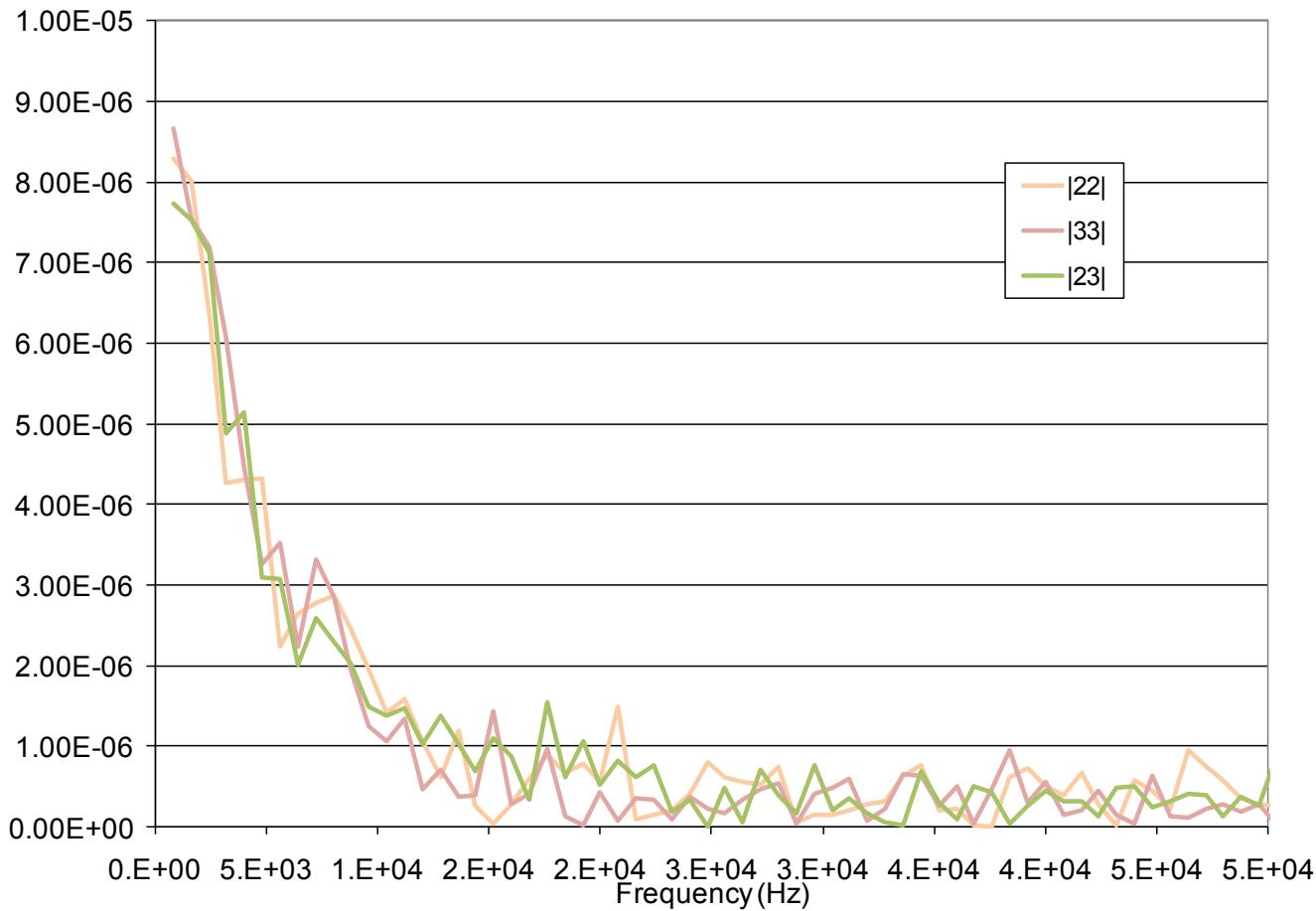


Measured data: NPOD

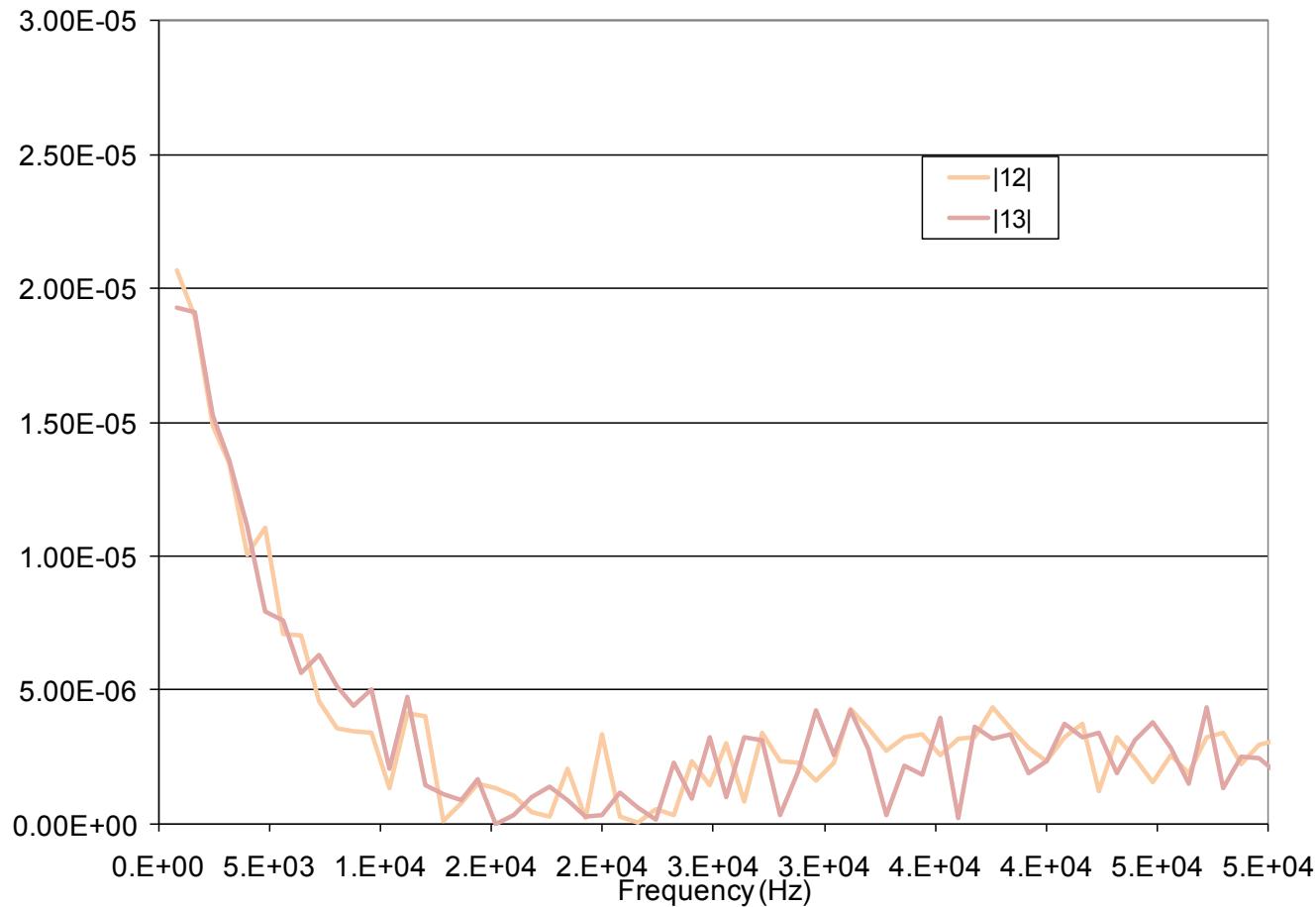


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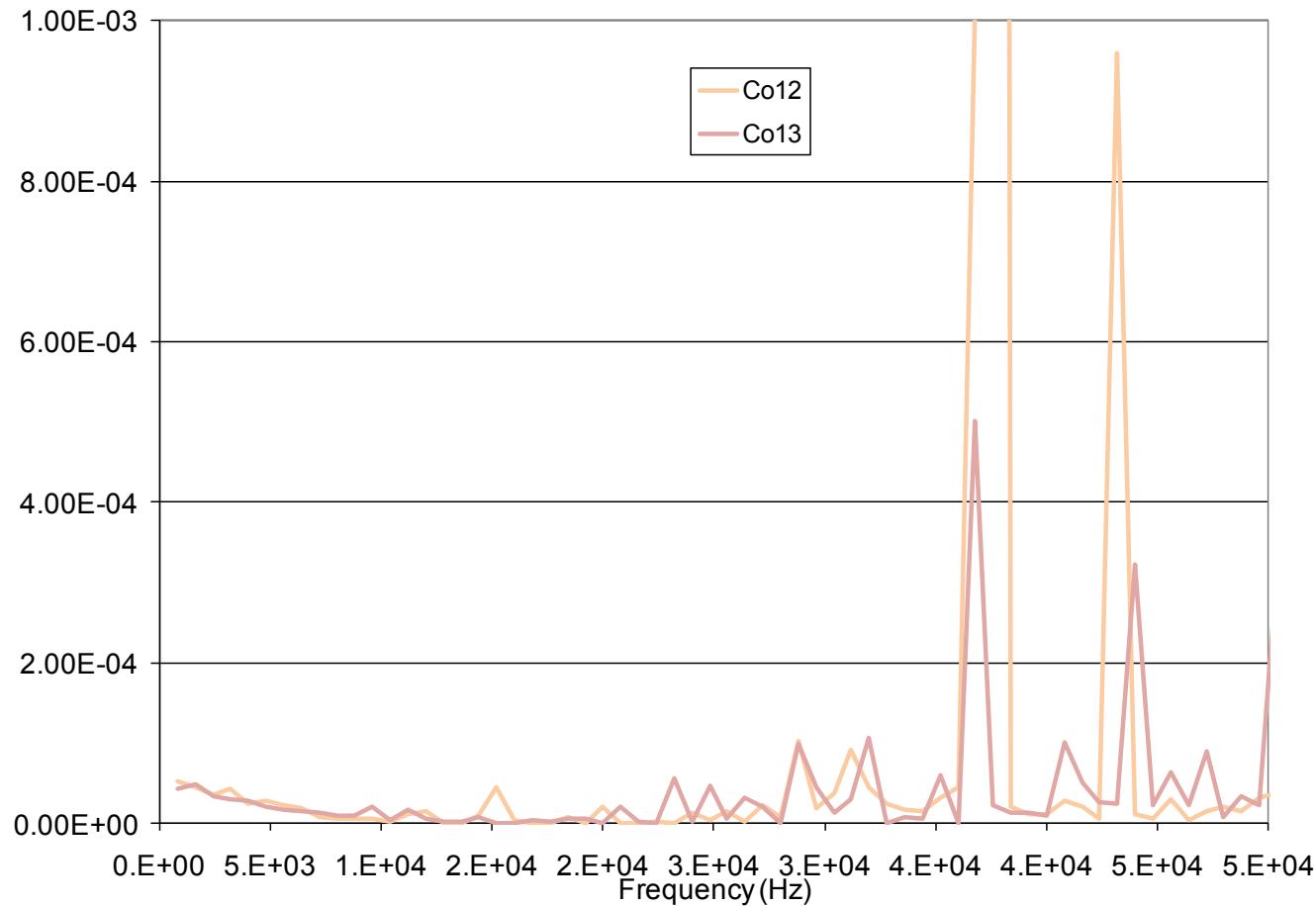
Measured data: NPOD



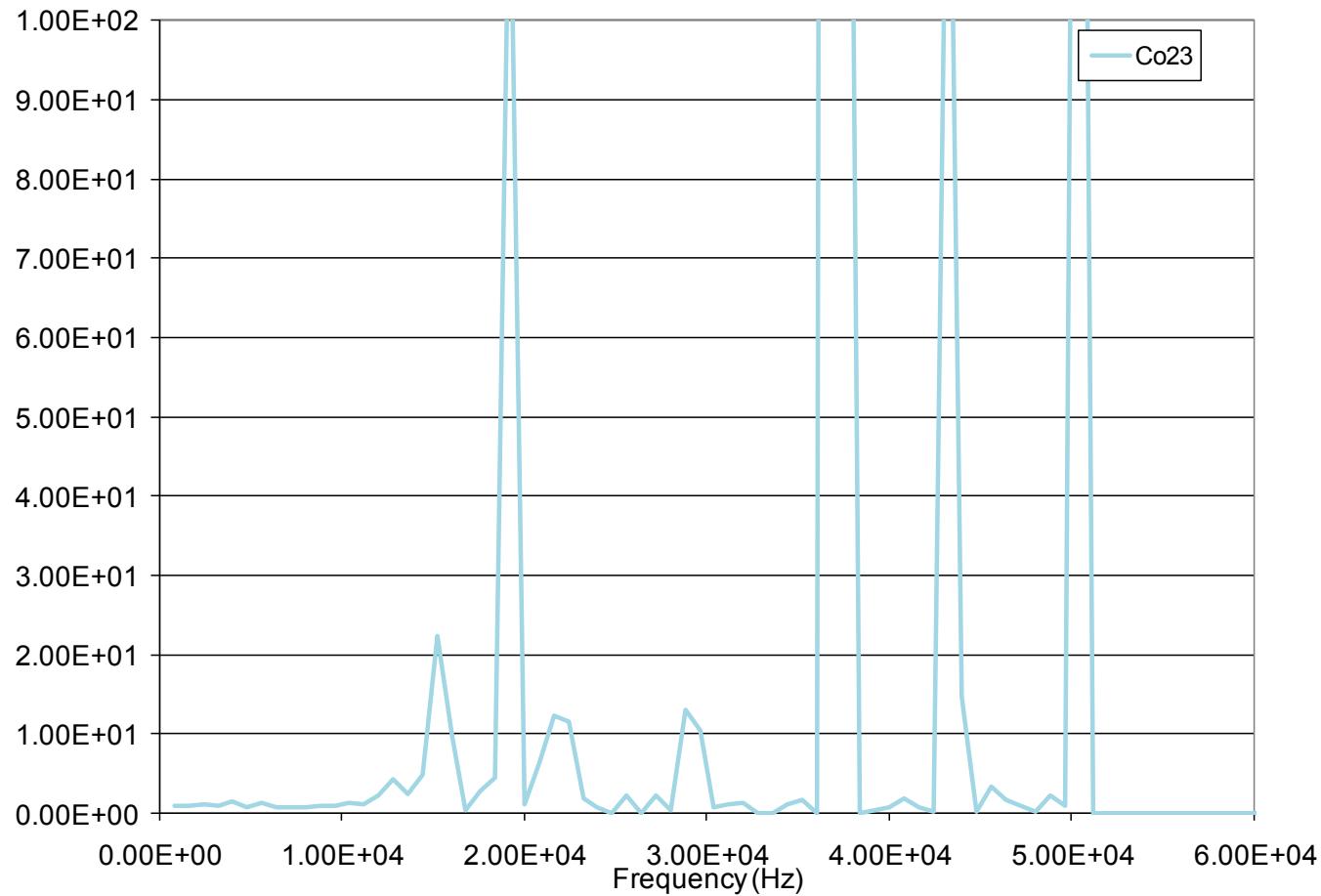
Measured data: NPOD



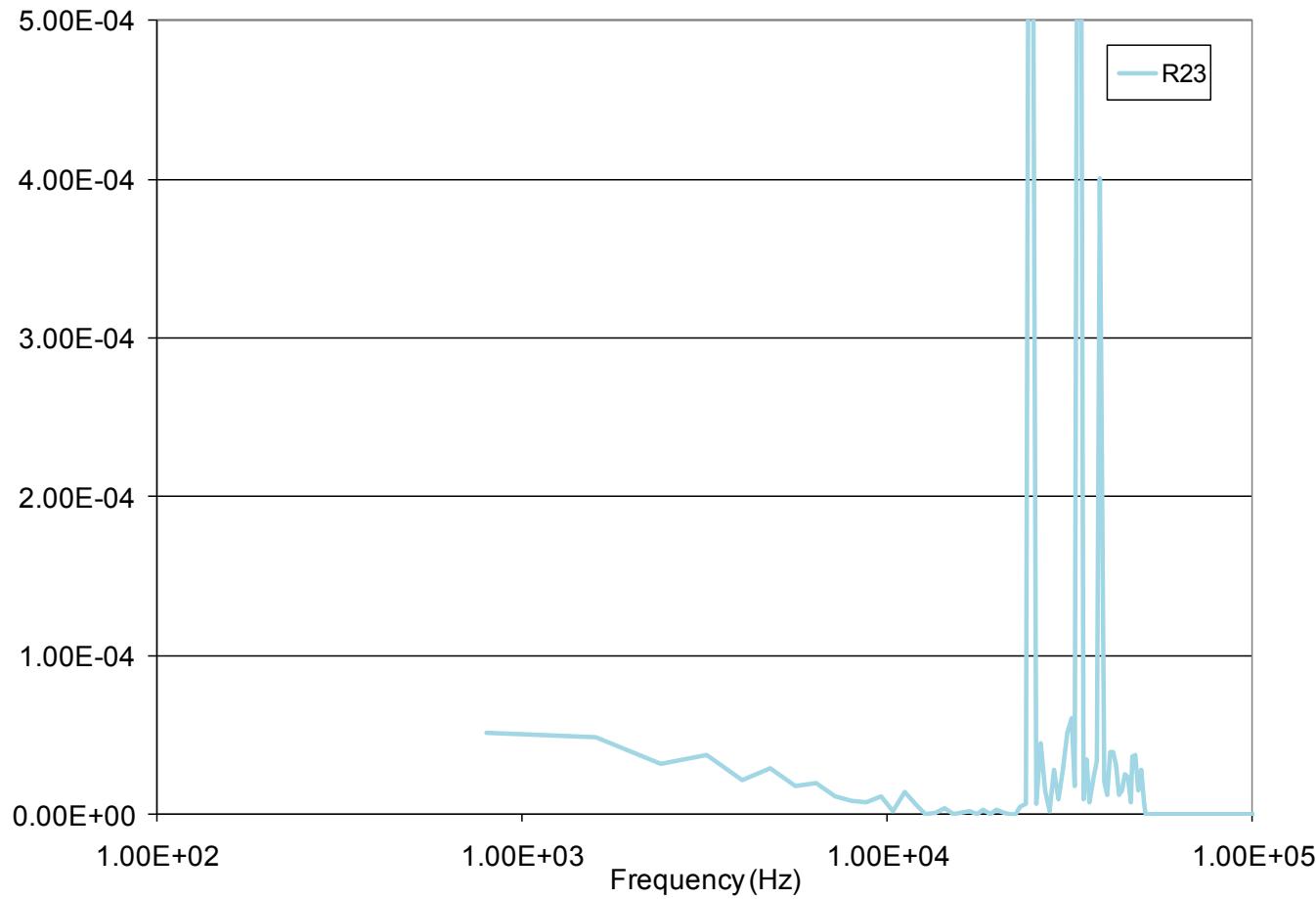
Measured data: NPOD



Measured data: NPOD



Measured data: NPOD



Conclusions

- MCNP-DSP: converting the entire data set from the time to frequency-domain works well.
- 4 He-3 tube data: time-domain data did not look good. Many possibilities exist: insufficient statistics, the method employed was incorrect, mathematical errors, etc.
- NPOD data: Had sufficient statistics, time-domain data looked good. Some of the frequency-domain data looked okay but when combined (for coherence and R) they did not show expected shapes.

Conclusions

- Even if we can get this working correctly, do we want to do measurements with a Cf-252 SIC for future subcritical measurements?